Design and Fabrication of Triple Roll Mill for Production of Bar Soaps in Nigeria

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ABSTRACT

A triple roll mill was designed, fabricated, and tested using locally sourced and affordable materials for bar soap production. The machine comprises a shaft, rollers, bearings, hopper, and stand, powered by an electric motor. Soap solution was prepared in the laboratory and processed into pellets, which were fed into the machine's hopper for smoothening, adhesion, and fine texture enhancement. The machine's rotational speed was found to be smooth and moderate. The estimated cost of design and construction was ₦207,500. The development of this machine addresses the need for affordable roller mill technology for local bar soap manufacturers in Nigeria.

Keywords: bar soap; design; triple roller mill; processes; cost.

INTRODUCTION

Various equipment is employed in the commercial production of bar soap, including mixer machines, refiner plodders, roller machines, cutting machines, stamping machines, and automatic soap packing machines, which are essential for streamlining the production process of bar soap (Ashurst, 2025). To set up a soap industry with all these equipment installed is worth $30,000 to $100,000, which is approximately ₦48,222,600 - ₦160,742,000 as of 2025, aside from other operational costs like land and building, raw materials and ingredients, and labor cost. However, according to Future Market Insights (2023), the Bar Soap Market is expected to increase at a 4.04% CAGR from 2023 to 2033, growing from USD 30.34 billion in 2023 to USD 45.08 billion in 2033, driven by shifting customer demand in the market.

In spite of this, young and aspiring entrepreneurs have been utilizing locally made processes to produce quality bar soap and market it in minimal quantities, which is not up to the commercial demand. According to 6Wresearch (2025), the Nigeria Soap Market size is expected to grow at a CAGR of 8.5% during 2025-2031, depicting the necessity of sourcing a more cost-effective process that will benefit every entrepreneur.

Unlike every other equipment in a bar soap industry, roller mills are machines used in homogenization, grinding, shaping, and enhancing the appearance of the soap, which is a very essential finishing production section by refining texture and improving the quality of the soap. They are a type of compression mill that utilizes single, double, or triple cylinder-shaped heavy wheels mounted horizontally. The mill operates by rotating the cylindrical wheels around their long axis against endplates of opposing pairs (ThomasNet, 2020).

Triple roll mills, featuring three adjacent rollers rotating at progressively faster speeds, are particularly effective. The rolls are designated as the feed roll, center roll, and apron roll. Materials, typically in pellet form, are fed between the feed roll and the center roll. The functional design of the triple roll mill makes it a preferred method for separating finely divided particles. In these mills, the three horizontal rolls rotate in opposite directions at different speeds. Soap materials prepared for refining are placed between the center and feed rolls. The materials are then transferred from the center roll to the apron by adhesion, where shear force between the rolls creates the desired dispersion. A smaller gap between the rolls generates greater shear force. The gap is typically set at approximately 0.001" (Wikipedia, 2020). The material is removed from the apron roll using a take-off knife. The process is repeated until the desired level of refining is achieved.

Fig. 1 Industrial view of Triple Roller Mill

The requirements for roller milling machines in many industries are demanding, resulting in high costs for bar soap manufacturers. Industrial roller mills, designed for large-scale production, can range in price from tens of thousands to hundreds of thousands of dollars, depending on their size, capacity, and features (ThomasNet, 2020). This high cost presents a significant economic challenge for local bar soap manufacturers in Nigeria, who often operate on smaller scales with limited capital. They may struggle to afford this equipment, hindering their ability to increase production volume and improve product quality, which ultimately affects their competitiveness and profitability. This project aims to address this challenge by designing and fabricating a triple roll mill using locally available and affordable materials. This will increase bar soap production in commercial quantities cost-effectively while maintaining product quality.

The specific objectives of this project were to:

- Familiarize users with the operation of triple roll mills in bar soap production.
- Develop a scaled-down version of industrial triple roll mills for local use.
- Carry out the engineering design of the machine using SolidWorks.
- Fabricate the machine.
- Test the machine to evaluate its efficiency in bar soap production.
- Process soap pellets using the machine.
- Estimate the cost of the machine.

The quality of the final bar soap product is influenced by controlling the following parameters:

- The gap between the rollers.
- The speed differential between the rolls.

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- The feed rate.

Extent of Past Works

Jinfeng Chen et al. (2012) successfully exfoliated single and few-layer graphene sheets from natural graphite using a three-roll mill with a polymer adhesive. Wånge (2020) fabricated a bar soap dispenser, incorporating shredding ideas and an innovative soap dish design.

Previous work on three-roll mills has focused on the properties of polymer adhesives and exfoliation conditions, such as rolling time, temperature, and speed (Chen et al., 2012). Wånge's (2020) design for a soap dispenser included an innovative soap dish and water drainage system to heighten stability. More recent research has also explored the use of three-roll mills in various applications, such as the production of nanocomposites (Zhou et al., 2015) and the processing of high-viscosity materials (Ha et al., 2019). However, the limitations of applying three-roll mill technology to small-scale, cost-effective bar soap production for local manufacturers in Nigeria have not been adequately addressed. This project aims to fill this gap by developing an affordable and efficient triple roll mill using locally sourced materials.

MATERIAL AND METHODS

Soap Pellet Preparation:

Soap pellets from the Chemical/Petrochemical Engineering Laboratory at Akwa Ibom State University, Ikot Akpaden, Mkpat Enin L.G.A., Akwa Ibom State, were used as the feed material for the roller mill.

Collection of Fabrication Materials

The materials used for the fabrication of the triple roll mill were sourced from Orata Market, Port-Harcourt Express Road, Aba, Abia State, and included rollers, sprockets, end plates, screw adjusters, bolts, and a galvanized sheet for the discharge apron. The electric motor (Model: YL112M-4, 4KW, 5.5HP, 50Hz, 1450r/min, 220V) was provided by the Department of Chemical/Petrochemical Engineering.

Each unit of the machine was constructed separately using workshop tools and welding techniques. The different parts of the machine are described below:

Fig. 2 A typical view of an electric motor

Apron: The apron, constructed from a galvanized sheet, receives the ground materials. It was dimensioned and welded.

Stand: The stand was fabricated from angle iron.

Shafts: Three steel shafts were used.

Machine Body: The machine body has a rectangular shape and was constructed from a galvanized sheet. The dimensions were selected to ensure portability and effective functionality.

Hopper: The hopper, fabricated from four pieces of galvanized sheet welded together, has a trapezoidal shape. The base dimensions were determined based on the dimensions of the rollers.

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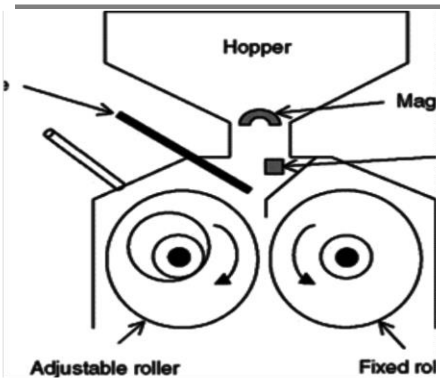

Fig. 3 Diagram showing a typical roller mill hopper

The Design of a Hopper

The hopper as shown in figure 2 is a crucial component of the triple roll mill, serving as the inlet for the material to be processed. A well-designed hopper ensures a consistent and controlled feed of soap pellets into the rollers, which is essential for achieving uniform particle size reduction and a smooth, consistent product. The shape and dimensions of the hopper influence the flow rate of the material, prevent bridging or clogging, and minimize material waste (Aguilar et al., 2008).

In this project, the hopper was designed with a trapezoidal shape to facilitate the flow of soap pellets and prevent them from accumulating in corners. The base dimensions of the hopper were determined based on the dimensions of the rollers to ensure that the pellets were fed evenly across the roller surface. The volume of the hopper was calculated to hold a sufficient quantity of soap pellets for continuous operation, reducing the need for frequent refilling.

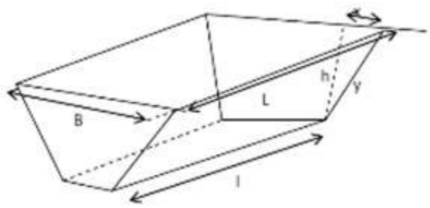

Fig. 4 Diagram showing the sketch of the hopper

Area of a trapezium base = $\frac{1}{2}(a+b)h$ (1)

Where $a = 25cm$; $b = 30cm$; $h = 15cm$

Therefore; Area of hopper = 412.5 cm

Volume = Ah (2)

Where A is the Area and h is the height of the trapezium ends.

Where the height of the trapezium ends (which is the length of the roller) = 35cm

Therefore, Volume of the hopper =14437.5 cm^3

The Frame: The frame was constructed from four angle irons cut with a hand hacksaw and welded together.

Bearings: Four bearings were welded to the top of the frame to support the shafts.

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Fig. 5 Diagram showing roller bearings

The Shafts with Rollers: The shafts, made of steel, pass through hard, thick, hollow iron rollers. The rollers are cylindrical, with a metal face welded to the cylinder. A hole at the center of the metal face allows the shaft to pass through. The arrangement of the shaft and roller, passing through the bearings, enables the rotation of the shaft and roller.

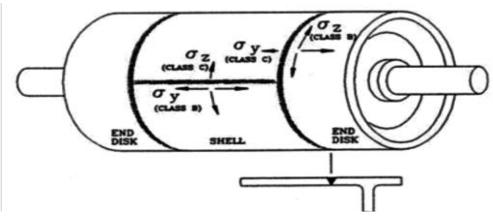

Fig. 6 Diagram showing roller with shaft

The Design of a Shaft Diameter

$$d = \sqrt[3]{\frac{1.33 \times 106P}{N}} \qquad (3)$$

Where d – Diameter of the shaft

P – Shaft power

N – 75% of critical speed

A 5.5HP electric motor with the following specifications was used:

Voltage = 380/420V

Revolution per minute (rpm) = 2800

Hertz = 50

Frame = 132

Such that 5.5hp equals 418.389kg-m/s or 4101.35Nm/s and N = 293.21cm/s

$$d = \sqrt[3]{\frac{1.33 \times 106 \times 418.389}{293.21}}$$

$$d = 5.8594 \approx 6cm$$

Therefore, the designed shaft diameter used was 6 cm.

The Angle of Nip: The angle between the two rollers was designed to be adjustable using a spring-loaded mechanism or an adjustment at the edge of the frame. This adjustability accommodates feed materials of varying sizes.

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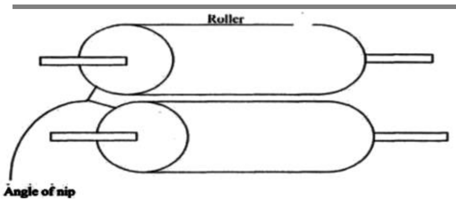

Fig. 7 Diagram showing the angle of nip of a roller mill

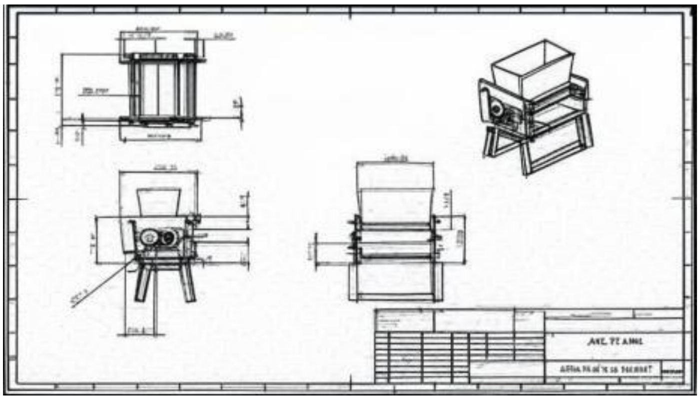

Fig. 8 Dimensioning of the machine

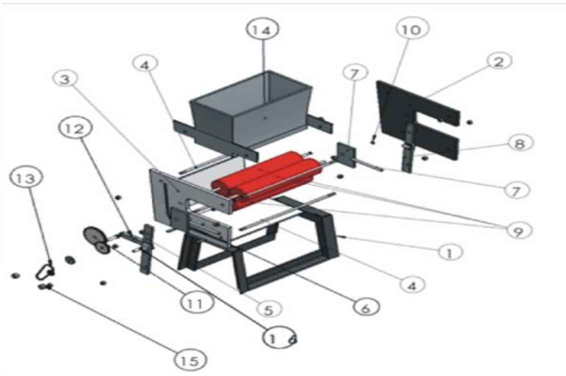

Fig. 9 Labelling of the machine

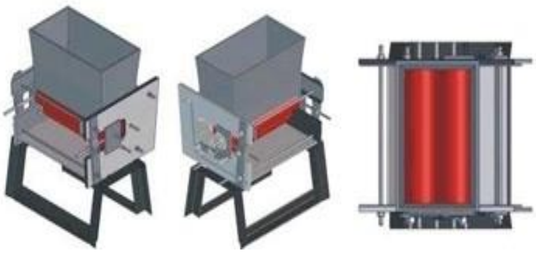

Fig. 10 Rear, right and top views of the machine

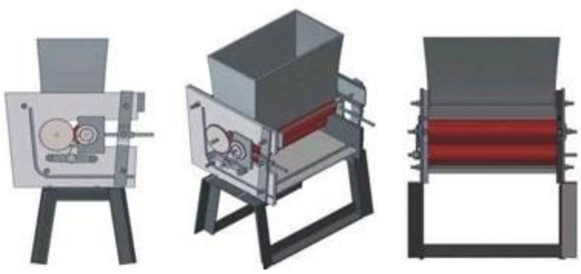

Fig. 11 Side, 3D-view, and front view of the machine

Fabrication Procedure

The triple roller mill was designed and detailed in technical drawings prior to fabrication. Fabrication took place at Blossom Engineering Fabrication Workshop, located in Obot Idim, Uyo Local Government Area, Akwa Ibom State, Nigeria. All required materials, including stainless steel rollers, end plates, a discharge apron, gears, and fastening screws, were procured from Aba Market, Abia State, Nigeria, ensuring compliance with industrial standards for durability and performance.

The fabrication process followed a systematic sequence of steps:

- **Machining of Roller Shafts:** The roller shafts were machined to precise dimensions (as specified in the technical drawings) using a lathe to ensure proper fit and alignment within the mill assembly.
- **Fabrication of Bearing Couples:** Bearing couples were manufactured from high-grade steel to support the rollers and facilitate smooth rotation, minimizing friction and wear during operation.
- **Assembly of the Frame:** The frame was constructed using mild steel beams, shaped to the required geometry, and welded to form a rigid structure. Two frames were securely fastened to the roller mill assembly using high-tensile bolts to ensure stability under operational loads.
- **Hopper Construction:** The hopper was fabricated from 2 mm thick stainless steel sheets, cut and welded to form a funnel-shaped structure, ensuring efficient material feeding into the rollers.
- **Installation of Adjustment Assembly:** An adjustment assembly, consisting of precision bolts and spacers, was installed to allow fine-tuning of the roller positions, enabling control over the gap between rollers for varying material fineness.
- **Sprocket and Gear Installation:** Sprockets were bolted to both sides of the roller mill to enhance structural stability. Driving gears, machined to match the sprocket specifications, were mounted to transmit rotational motion to the rollers, ensuring synchronized operation.
- **Final Assembly:** All components were assembled, with bolts torqued to manufacturer-recommended specifications, and the machine was inspected for alignment and functionality.

Bar Soap Production Using Triple Roller Mill

The bar soap production process utilized the hot process method, followed by refinement in the triple roller mill to achieve a uniform texture. The procedure involved the following steps:

1. **Ingredient Preparation:** Precise quantities of oils, water, and lye were measured. The oils were combined in a stainless steel mixing vessel, and the lye was dissolved in the distilled water under controlled conditions to prepare the soap mixture.
2. **Saponification Process:** The soap mixture was transferred to a reactor and heated to 80°C with continuous stirring to ensure uniform reaction. This facilitated the saponification reaction, converting the oils, lye, and water into soap and glycerin.
3. **pH Testing for Saponification Completion**: The soap mixture was tested using a pH strip to confirm complete saponification. The target pH range of 8–10 was achieved, indicating the reaction was complete and the mixture was safe for further processing.
4. **Addition of Fragrances and Colors:** After cooling the mixture to 50°C, 10 mL of lavender essential oil and colorants were added to achieve the desired scent and appearance. The mixture was stirred to ensure even distribution.

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5. **Soap Refinement in the Triple Roller Mill:** The soap mixture was fed into the hopper of the triple roller mill. The mill was operated at a roller speed differential of 1:3:9 (fastest to slowest roller) to refine the soap, eliminating lumps and achieving a uniform texture through shear forces.

6. **Pelletizing, Extrusion, and Finishing:** The refined soap was pelletized using a pelletizer with a 5 mm die, then extruded into bar shapes using a soap extruder. The bars were stamped with a custom mold for branding and prepared for packaging, sale, and use.

RESULTS AND DISCUSSION

The Fabricated Pictures of the Machine

Fig. 13 Rear and side views of the machine

Fig. 14 Electric motor attached to the machine

Fig. 15 Front and top views of the machine

Fig. 16 Bar soap produced using the triple roll mill

Cost Estimation of the Machine

The cost analysis of the machine is presented in Table 1.

Table 1: Cost Analysis of the Machine as of 2022

S/N	MATERIAL	AMOUNT (N)
1	Chains	5000
2	Rolling gears	7000
3	Spray paint	4500
4	Metal sheet	25000
5	Frame support bolt	4000
6	Rollers	13000
7	Each bolt(8mm)	5000
8	1 packet of electrode	4000
9	Miscellaneous	50000
	Total	117500

Note: This costing excludes the gearbox (N45,000) and the electric motor, which were donated by the Department of Chemical/Petrochemical Engineering, AKSU and this was predicted to increase by factor of 1.2.

Machine Development and Performance Evaluation

Fabrication and Cost Analysis

The locally fabricated triple roll mill was developed using standard metal cutting and joining techniques, including hacksawing, cutting disc operations, electric arc welding, and bolted joints. The fabrication process was completed at a cost of ₦207,500, significantly lower than the cost of industrial roller machines, which can range from ₦1,500,000 to ₦3,800,000 depending on capacity and features according to jiji market (2022). This cost advantage makes the locally fabricated machine a viable option for small-scale soap manufacturers with limited capital.

Performance Evaluation

The fabricated triple roller mill, as depicted in the Fig. 11-14, was subjected to rigorous performance testing using pre-mixed soap ingredients. The soap mixture, consisting of saponified oils, lye, and additives dried, was introduced into the hopper at a feed rate of 2 kg per batch. The three rollers, operating at a speed differential of 1:3:9 (fastest to slowest roller), effectively mixed and homogenized the soap mixture, producing uniform soap pellets. The milled material was collected via the discharge apron, ensuring minimal material loss during operation.

During testing, the machine operated without mechanical failures, demonstrating smooth and stable performance over a 5-hour continuous run. Feedback from prospective users, specifically a group of students undergoing their Student Industrial Workshop Experience Scheme (SIWES) in soap production, confirmed the machine’s reliability and effectiveness. Users reported that the machine consistently produced soap pellets with a smooth texture, free of lumps, which improved the overall quality of the final bar soap product. This enhancement addressed common challenges in local bar soap production, such as inconsistent mixing and poor texture, thereby improving the marketability of the soap.

Power Efficiency Analysis

The locally fabricated triple roller mill was powered by an electric motor with the following specifications: 4 kW (4,000 W) power rating, 4.4 HP (1 HP = 746 W, so 4.4 HP = 3,282 W), 50 Hz frequency, 1450 rpm rotational speed, and 220 V operating voltage. To evaluate the power efficiency of the machine, the theoretical power consumption was calculated and compared to an industrial standard triple roller mill with identical operational parameters.

$$\eta = \frac{3{,}282}{4{,}000} \times 100 = 82\%$$

The locally fabricated machine achieves an efficiency of approximately 82%, which is competitive compared to industrial roller machines that typically operate at efficiencies of 85–90%. While slightly less efficient, the locally fabricated machine offers a substantial cost advantage, making it an attractive option for small-scale operations.

Observation

Preliminary tests at the Chemical Engineering Laboratory, AKSU, confirmed the smooth operation of the machine. The problems associated with local bar soap production, such as improper mixing of soap ingredients, poor fragrance performance, poor soap texture, soap breakage during use, and lack of translucency, were reduced. The texture of the soap pellets produced using the triple roll mill was comparable to that of bar soap produced without the milling machine. Furthermore, the developed machine offers a more cost-effective production and maintenance solution compared to imported alternatives.

The triple roll mill effectively mills high-viscosity pastes. Its large surface contact area and cooled rollers maintain low temperatures, even with significant dispersion work. The adjustable gaps between the rolls allow for precise control over the dispersion process.

CONCLUSION AND RECOMMENDATION

The triple roll mill was developed using locally sourced materials, resulting in a cost-effective and practical solution for local bar soap manufacturers. Its design, incorporating three rolls (one adjustable and two fixed), efficiently processed the feed material to achieve uniform mixing and improved texture. Performance evaluations demonstrated the machine's capability to meet production requirements, with results closely aligning with the standards of industrial-scale machines.

This development underscores the potential of locally manufactured triple roll mills to enhance productivity while significantly reducing reliance on costly imported equipment. The adoption of such machines is strongly recommended to promote local manufacturing, support small-scale entrepreneurs, and address the growing demand for bar soap production.

Contribution to Knowledge:

This research enhances the understanding of the design and working principles of unit operations in chemical industries, such as soap production. It also fosters collaboration between engineers, technicians, craftsmen, welders, and fabricators in the fabrication of chemical industrial equipment and the production of bar soap.

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REFERENCES

1. 6Wresearch. (2025). Nigeria Soap Market Report. Retrieved from https://www.6wresearch.com

2. Aguilar, J.M., Hernández, C., Medina, A., & Calvo, J.L. (2008). Design and optimization of hoppers for granular materials. Chemical Engineering Research and Design, 86(1), 25-32.
3. Ashurst, M. (2025). Soap Industry Setup Costs. Future Market Insights. Retrieved from https://www.futuremarketinsights.com
4. Blake JH, Minet RG, Steen WP. (1963). Pressure developed in a roll-type briquet press. Proceedings of the 8th Biennial Conference, International Briquetting Association, 38–48.
5. Chen, J., Duan, M., & Chen, G. (2012). Continuous mechanical exfoliation of graphene sheets via three-roll mill. Journal of Materials Chemistry, 22(37), 19625–19628. https://doi.org/10.1039/C2JM33740A
6. Dow, S. (1990). About Soap. Procter & Gamble. (513) 983-1100.
7. Ephraim, D. (2017). Roller mills: Precisely reducing particle size with greater efficiency. Modern Process Equipment. Retrieved from www.powderbulk.com
8. Esonye, Ezinne Ugonna, Esonye, Chizoo. (2018). Economic Feasibility Study on Sitting of Soap Plant in the South Eastern Nigeria. Journal of Economics and Sustainable Development, ournal of Economics and Sustainable Development Vol.9, No.7, 98-107. Retrieved from www.iiste.org
9. Eugene A.A and Theodore B. (1986). Standard Handbook for Mechanical Engineering. New York: McGraw Hill Book Company.
10. Future Market Insights. (2023). Bar Soap Market Trends and Forecasts. Retrieved from https://www.futuremarketinsights.com
11. Ha, J.-H., Lee, S.-E., & Park, S.-H. (2019). Effect of dispersion by three-roll milling on electrical properties and filler length of carbon nanotube composites. Materials, 12(23), 3823. https://doi.org/10.3390/ma12233823
12. IEC (International Electrotechnical Commission). (2022). Motor efficiency standards and testing procedures. https://www.iec.ch
13. Interdisciplinary Lab no.2: synthesis and properties of soap. (2017). The Royal Society of Chemistry, 2-4. Retrieved from http://www.rsc.org/suppdata/c7/rp/c7rp00133a/c7rp00133a2.pdf
14. IUPAC, Compendium of Chemical Terminology, 2nd ed. (the "Gold Book") (1997). Online corrected version: (2006–) "Soap". doi:10.1351/goldbook.S05721. (n.d.).
15. Jinfeng Chen, Miao Duan and Guohua Chen. (2012). Continuous mechanical exfoliation of graphene sheets via three-roll mill. Journals of material chemistry, 19625–19628.
16. JR, J. (1965). A rolling theory for granular solids. ASME J App Mech, E32:842–848.
17. Kasdan, I. F. (2014). The history and origin of soap. Chagrin valley soap and salve company.
18. Kurtz BE, Barduhn AJ. (1960). Compacting granular solids. Chemical Engineering Programme, 56:67–72.
19. Madaminov, A. A. (2021). To the theory and practice of creating modern. IOP Conference Series: Materials Science and Engineering, 1-8.
20. Mills, T. J. (2019). Shear forces in roller milling applications. Industrial Chemistry Journal, 21(4), 155–161.
21. Mingda BI, Fernando Alvarez-Nunez, Francisco Alvarez. (2014). Evaluating and Modifying Johanson’s Rolling Model to Improve its Predictability. Research Article – Pharmaceutics, Drug Delivery and Pharmaceutical Technology, 2062-2071.
22. ThomasNet. (2020). Three roll mills. Retrieved from https://www.thomasnet.com/products/three-roll-mills-10791322-1011130209
23. Tyree, L. S. (2015). The Five Qualities of a Good Bar of Soap. Blog, Cold Processed Soap, Hot Process Soaps.
24. Ukoyo, O. (2021). Major Equipments Used In The Production Of Soap. Organic Chemistry (CHM 304).
25. Wånge, H. (2020). Iver - A Bar Soap Dispenser. Spring, 2-61.
26. Wikipedia. (2020). Triple Roll Mills. Retrieved from https://www.wikipedia.org.
27. Zhou, Y., He, Q., Wang, G., Zheng, B., Qi, M., Li, X., & Kong, L. (2018). Effects of two nano-ZnO processing technologies on the properties of rubber. Applied Nanoscience, 8(8), 2009–2020. https://doi.org/10.1007/s13204-018-0871-0.

APPENDIX

The labelling of triple roller machine parts with descriptions.

Label Number	**Component Name**	**Description**
1	Frame/Base	Provides structural support and covers the sides of the roller mill for protection.
2	Roller 1	A cylindrical tool for refining and grinding soap materials to achieve uniform texture and particle size.
3	Roller 2	Another roller for effective compression and dispersion of materials during the milling process.
4	Roller 3	Completes the three-roll setup, facilitating efficient homogenization through progressive speed variations.
5	Roller Adjustment Knob 1	Mechanism to adjust the gap between Roller 1 and Roller 2 for particle size.
6	Roller Adjustment Knob 2	Mechanism to adjust the gap between Roller 2 and Roller 3 for finer output.
7	Roller Adjustment Knob 3	Additional adjustment mechanism for precise roller alignment or tension.
8	Side Plate/Frame 1	Provides the main framework that houses and secures all components of the roller mill.
9	Side Plate/Frame 2	Reinforces the structure, ensuring durability and stability during operation.
10	Scraper Blade	Blade to scrape processed material off the final roller for collection.
11	Discharge Tray/Plate	Tray or chute where the final processed material is collected after milling.
12	Hopper	Holds soap material before feeding it into the rollers for processing.
13	Hopper Support	Stabilizes the hopper, ensuring consistent flow of materials to the rollers.
14	Base	The foundation of the roller mill, ensuring balance and preventing vibrations during operation.
15	Base	Ensures uniform load distribution across the mill setup.
16	Fasteners	Bolts or screws used to secure various components of the mill together.